Sec 1| Soil كل سكاشن ال ①

8\1 Ramy tarek

Soil Mechanics

• **Basic properties:-**
- weight relation (w)
- volume relation (V)
- weight/volume relation (γ)
- Iderzed phase Digram (Block)

• **Index properties:-**
- Corse grain soil
- fine grain soil.

وفيها توضح التدرج الحبيبي للتربة حتى يتم التعرف على نوع التربة

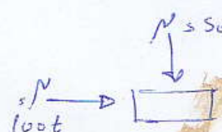
(Sand (S), Gravel (G), Clay (C), silt (M))

• **Engeneering properties of soil:-**
- permability.
- Compresability.
- shear strangth.

خواص التربة.

⇒ Different Between soil and any stracture material:-

1) High Variable with Distance — تكون مختلفة كلما زادت المسافة مع اختلاف الأماكن
2) Non-Homogenouse matrial.
3) Nationl Material. — كل منطقة لها التربة الخاصة بها
4) orthotropic Material.



- تختلف حجم العينة باختلاف الحمل (أفقي ورأسي)

Sec 2|

⇒ Basic soil Classification:- * By particuls.
* By plasticity.

I) By particals:-

a) Course grain soil
* Gravil (G) > 2.00 mm
* Sand (S) < 2.00 mm → 0.075

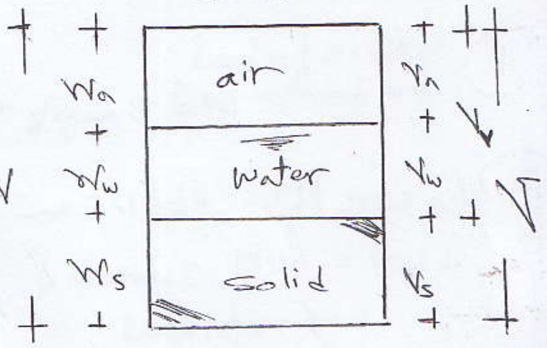
b) fine grain soil
* silt (M) 0.075 → 0.002 mm
* clay (C) < 0.002 mm

II By plasticity :-

a) Cohsionless soil (Gravel & sand)
b) Cohessive soil (silty & Clay)

⇒ Soil Contants or Phase Digrame :

(phase Digrame)



a) solids
b) air
c) water } voids

⇒ Basic soil properties :-

1) Volum Relation :

* e (voids ratio) $= \boxed{\frac{V_v}{V_s}} = \frac{V_a+V_w}{V_s}$
* n (prosity) $= \frac{V_v}{V} = \frac{V_v}{V_v+V_s} = \frac{\frac{V_v}{V_s}}{\frac{V_v}{V_s}+\frac{V_s}{V_s}} = \boxed{\frac{e}{1+e}}$
* S (Degree of satuation) $= \frac{V_w}{V_v}$ (dry sample $S=0$, saturated sample $S=1$)
* air Content $= a_c = \frac{V_a}{V_v} = 1 - S = \%$

2) Weight Relation :

$w_c = \frac{W_w}{W_s} = \%$ or $= \frac{e \cdot S}{G}$ (water Contant)

3) weight / volume Relation :

* $\gamma_w = \frac{W_w}{V_w}$, $\gamma_s = \frac{W_s}{V_s}$ $\qquad G = \frac{\gamma_s}{\gamma_w}$
* $\gamma_b = \frac{W}{V} = \frac{W_w+W_s}{V_s+V_v} = \frac{\frac{W_w}{V_s}+\frac{W_s}{V_s}}{\frac{V_s}{V_s}+\frac{V_v}{V_s}} = \gamma_s \frac{1+w}{1+e} = \gamma_w \cdot G \frac{1+w_c}{1+e}$
* $\gamma_d = \frac{W_s}{V} = \frac{\frac{W_s}{V_s}}{\frac{V_v}{V_s}+\frac{V_s}{V_s}} = \frac{\gamma_s}{1+e} = G \cdot \gamma_w \frac{1}{1+e} = \frac{\gamma_b}{1+w_c}$

Sec 3|

1) Uses of Index properties :
   a) give indecation of Engeneering properties.
   b) Soil Classification.

(Index properties of Course grain soil)

Grain size Distribution.
- Sevie analysis
- Hydrometer.

Relative diensity

$D_r = \frac{e_{max} - e}{e_{max} - e_{min}}$

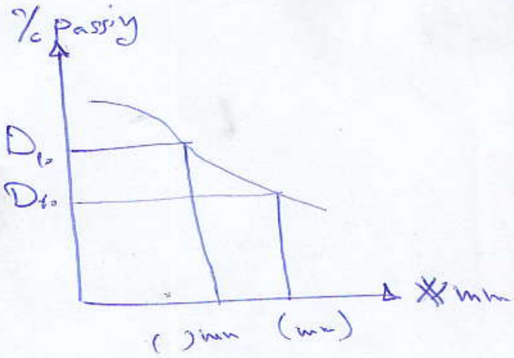
⇒ uses of grain size Distibution :

1) Determine persentage of Constitnse.
2) given of soil gradiation.
   - poorly gradet
   - well gradet

3) soil Classification
4) Designe of filter

⇒ gradiation of soil

1) Effective size (D_{10})
2) Coeficente of uniformty ($C_u = \frac{D_{60}}{D_{10}}$
3) Coef. Curvature ($C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$



⇒ If $C_u > 4$ Gravel
> 6 Sand
C_c ($1 \rightarrow 3$)
⇒ well grade
, else poorly graded

Sec5

Uses of atterberg limits :-

1. for soil classification.
2. for Higher "I_p", higer (A) Activity.

⇒ Activity (A) : is the ability of soil to absorb water with volume change.

$$A = \frac{I_p}{<2\mu}$$

⇒ purpose of classification of soil :-

* given an standerized naming to soil (S, M, CW, ...)
* given indecation for both soil properties and constitons.

⇒ Unified of soil classification system (USCS)

type	Main sambole	Secondry sampole
gravel	G	W → well
sand	S	P → poorly
silt	M	H → High plasticty
clay	C	L → low plasticty
peat	P	
organic	O	

(USCS)

1)

1. % passing (0.075) > 50% → Fine grain soil (M, C)
   < 50% → Coorse grain soil (S, G)
2. % passing from (4.75 mm) > 50% → sand (S)
   < 50% → gravel (G)
3. silt - clay

If PI > 0.73(L.L - 20) clay
PI < 0.73(L.L - 20) silt

If L.L ≥ 50% H : High plasticity
L.L < 50% L : low plasticity

If $C_u > 6$
C_c 1 : 3 i.e. well graded

(USCS) Unified soil classification system

1) * (0.075)% passing > 50 %

Yes → Fine graded | No → Coarse graded

2) If P.I > 0.73 (L.L - 20)

Yes → Clay (C) | No → silt (M)

If % passing (~~4.75~~ 2.00 mm) > 50 %

→ Sand (S) | → Gravel (G)

3) If L.L ≥ 50

Yes → High Plasticity (H) | No → low Plasticity (L)

If $C_u > 6$, C_c 1 : 3

Y → Well (W) | N → Poorly (P)

If $C_u > 4$, C_c 1 : 3

→ Well (W) | → Poorly (P)

Sec 7) Permability

→ lap. (k) | → field (k) | → (k) Emperical Correlation

lap. (k)

1) Constant haed

$$k = \frac{Q \cdot L}{A \cdot h} \text{ or } \frac{V \cdot L}{A \cdot t \cdot h}$$

where $Q = \frac{V}{t}$ (discharge)

2) falling head

$$k = \frac{a \cdot L}{A(t_2 - t_1)} \ln\left(\frac{h_1}{h_2}\right)$$

field (k)

1) falling head inside boreholle.

2) pumping out test

(k) Emperical Correlation

*) for Caorse grain soil

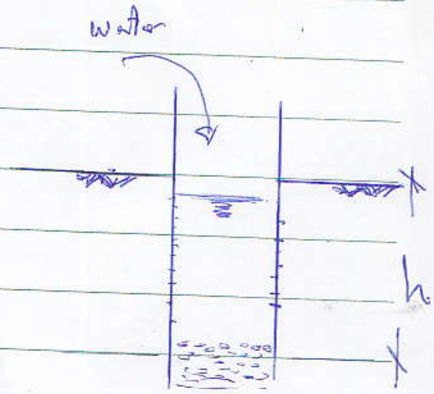
$k = 100 * D_{10}^2$ .... cm/sec

*) fine grain soil

$k = m_v \cdot C_v \cdot \gamma_w$

⇒ "k" in fields:

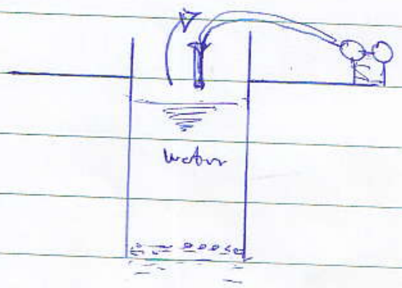
1) filling head inside bore holle:-



⇒ step: 1) drill bore holle
2) Install casing (perfote pip
3) put sand filter.
4) put water casing.
5) get "k" from $k = \frac{a \cdot L}{f \cdot r^2 (t_2 - t_1)} \ln \frac{h_1}{h_2}$

dis. advantage:- 1) time period too short.
2) sand filter undisterbed.
3) influnce value not correct.

2) Pumping out test:-



step: 1) Drill holle bore.
2) Install casing
3) sand filter
4) Calculate flow of water in (24) hour
5) get "k"

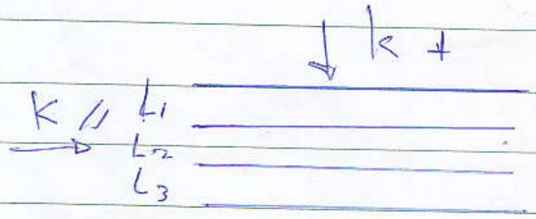
dis Adv.: mechin pumping can be stop at working ✕

⇒ factor effecity of permability :-
1. partical size (fine, Coarse)
2. partical shap ○ round, ◇ anglur
3. structure of partial flocculated, dispresed.
4. degree of saturation and ~~air~~ ~~vo~~ voids ratio.

⇒ Critical Condition (Quick sand condition) الرمال المتحركة

$$i_{(ci)} = \frac{\gamma_{sub}}{\gamma_w} = \frac{\gamma_{sat} - \gamma_w}{\gamma_w} \text{ or } \frac{G_s - 1}{1 + e}$$

⇒ k ⇒ for layer soil



$$k_{\parallel} = \frac{k_1 l_1 + k_2 l_2 + k_3 l_3}{L_1 + L_2 + L_3}$$

$$k_{\perp} = \frac{L_1 + L_2 + L_3}{L_1/k_1 + L_2/k_2 + L_3/k_3}$$

Sec 8 ⇒ Compactions the process of Decreasing volume by Expulsion of air From voids.

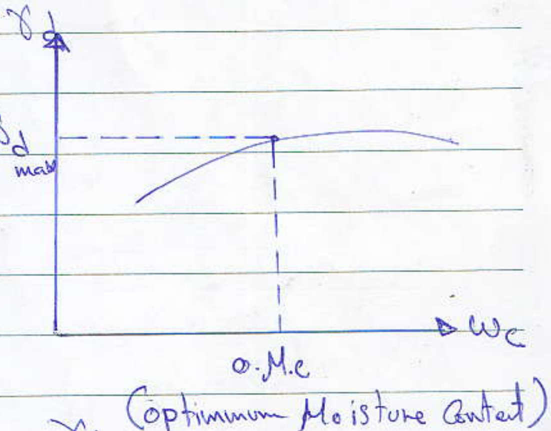
⇒ to Compaction occure or for Compact soil we need :
1. External energy
2. ~~Air in soil.~~
3. Continuose ~~pros~~ pores

⇒ Uses of Compaction :
1. increasing shear strength.
2. decreassing settelment
3. decreassing permability

⇒ factor effecting Compaction efficiency :-

a) type of soil
b) Method of Compaction.
c) Water Content.
d) Energy of Compaction.
e) layers thickness.

⇒ Determination of Compaction :

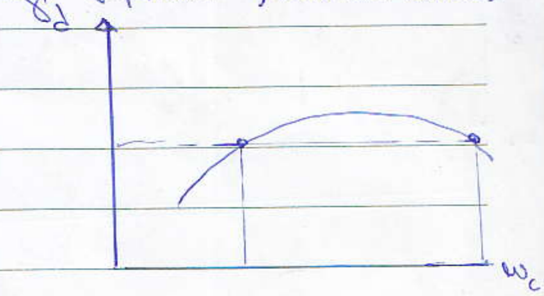


1) standard proctor test :

- no. of blows (25 blow)
- No. of layer (3)
- drop High (12 in)
- Hammer weight (5.5 lb)

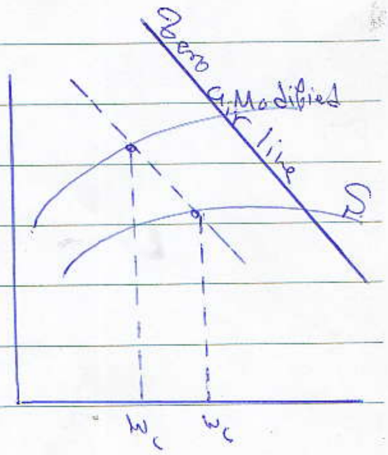
*) Relative Compaction

$$R_c = \frac{\gamma_{d\,field}}{\gamma_{d\,max}} \geq 95\,\%$$



2) Modified proctor test :

- no. of blows (25)
- no. of layers (5)
- drop highe (18 in)
- Hammer weight (10 Ib)



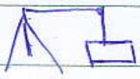
$$\gamma_d = \frac{G_s \cdot \gamma_w}{1+e} \qquad e = \frac{w_c \cdot G_s}{S}$$

$$= \frac{G_s \cdot \gamma_w}{1+\frac{w_c G_s}{S}} \qquad S \to 1$$

Mod w_c < Standr w_c

⇒ Methed of Compaction in field :-

1) preloading (عن طريق وضع ثقل على مساحة كبيرة لفترة طويلة) 

2) Rammers  (عن طريق الدك بواسطة قالب خرسانة / حمالة)

3) vibration هزازات

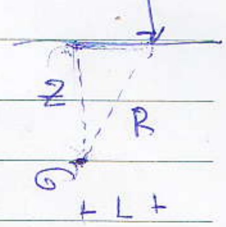
4) Rollers a) Steel Rollers
b) Shap foot Rolls

Sec : 9 ⇒ stress Distrbution : توزيع الإجهادات

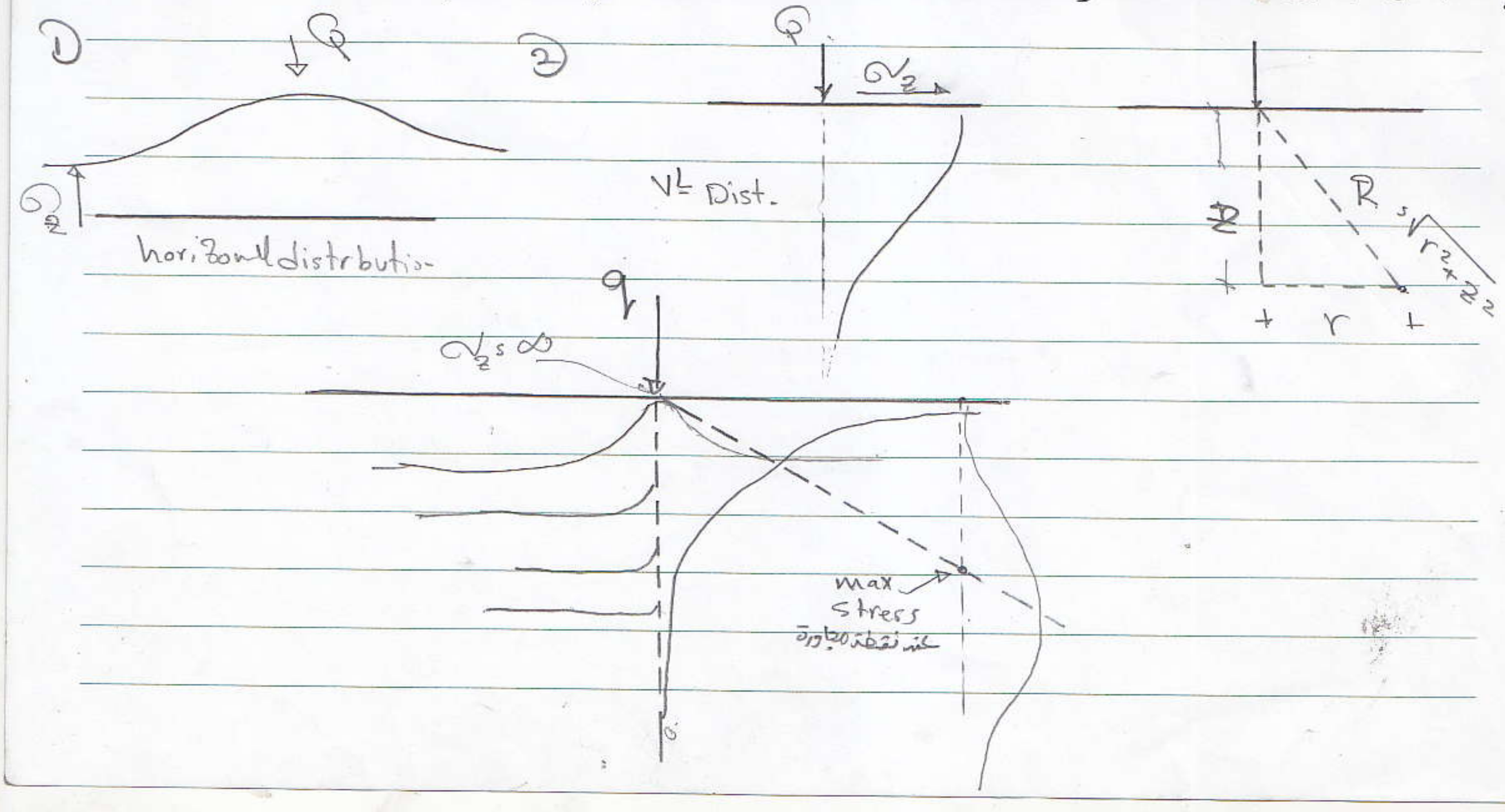
⇒ 1) Boussineq's Solution :- (Assurptions) مجرد فروض

1) soil is elastic materal.
2) " " isotropic " .
3) " " Homogenouse
4) semi infinite medium.
5) own weight of soil is neglicted.

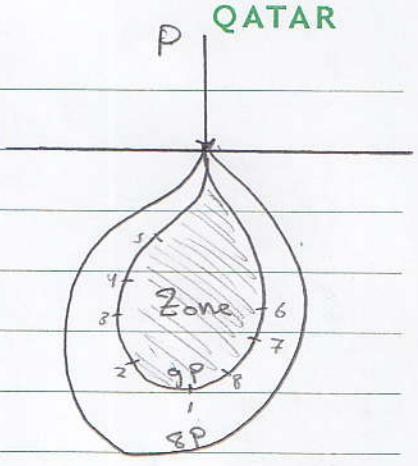
$$\sigma_z = \frac{2P}{3\pi} \cdot \frac{z^3}{R^5}$$



(point load) Digram of (Horizonal distrbution , Vertical Distrbution)



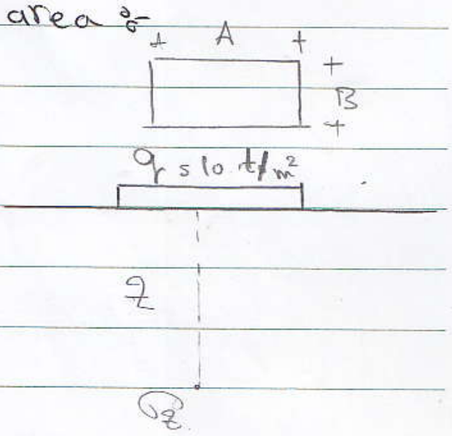
→ Iso bar: surface joining point of same stress الخط الواصل بين النقاط متساوية الاجهادات مثل (1, 2, 3 -- 8)



→ pressure bulb: Zone closed by a specific Iso bar هي المنطقة التي تحتوى على محوى من Iso bar متساوية الاجهاد مثل (8P, 9P)

2) New mark

→ Under the Corner of rectanguler area:

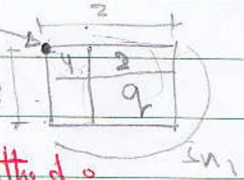


$\sigma_z = I_N * q$. where: $m = \frac{A}{z}$, $n = \frac{B}{z}$

n \ m	1	2	...
1	I_n	I_n	
2	I_n	I_n	
3			
...			

(I_N) For Center = $I_N * 4$

$I_N = I_{N_1} - I_{N_2} - I_{N_3} + I_{N_{4}}$



3) Approximate Method:

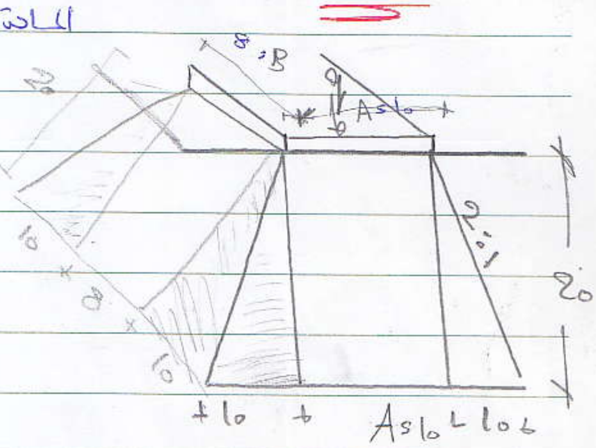
(trapizodial rule) مهم في الامتحان

• For rectanguler:

$$\sigma_z = \frac{q(8*10)}{(28*30)}$$

المساحة الطبيعية

المساحة الفعلية



• for Circle:

$$\sigma_z = \frac{q(\pi r^2)}{(\pi * r^2)}$$

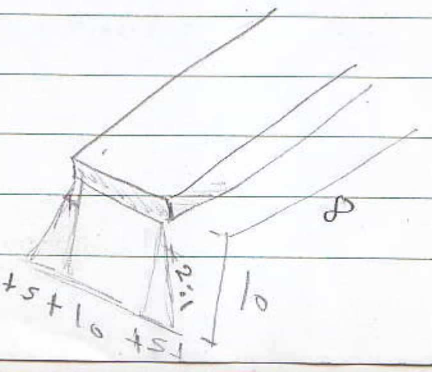
5

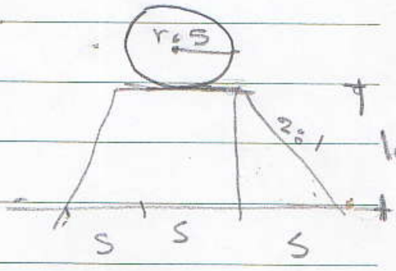
15

• for strip footing:

$$\sigma_z = \frac{q*(10*\infty)}{20*\infty}$$

$$= \frac{q*10}{20}$$



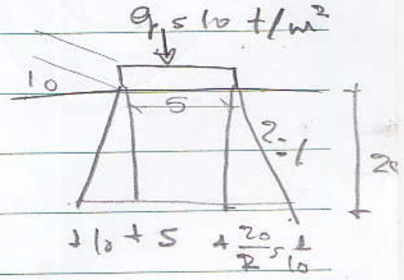


Sec: 10 ⇒ Stress Distrbution :

القرديـب الـ load , q ـ الحل

q = ... t/m^2 حل موزع
Loads = t حل مركز

لـوادات الـ load في الـ آلة لا تفريش Aeare



Example: $\sigma_z = \frac{q A_i}{A_z} = \frac{q(5*10)}{(30*25)}$

If given load = 10 t

$\therefore \sigma_z = \frac{10}{8*10} = ... t/m^2$

⇒ For (Newmark) ⇒ $\sigma_z = 4 * \frac{load}{Aera} * I_N$

Center ⇒ $\sigma_z \overset{or}{=} 4 * q * I_N$

⇒ Shere strength :

الشروط الواجب توافرها لمقاومة الـ Shere

⇒ for Shere : 1) Cohesion التماسك
2) Normal stress الحمل العمودي
3) friction الاحتكاك الطحي

taw

$\tau \propto C$, $\tau \propto E * \tan\phi$

shere strength, Cohison, Normal stress, زاوية الاحتكاك Fraction

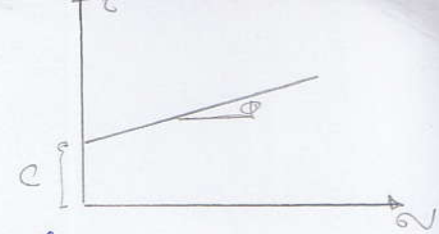
$\therefore \tau = C + \sigma \tan\phi$

Cohison, Normal stress, friction

⇒ Shere strength prameter : C, ϕ

Cohision, angle of interral pressure or Fraction

Sec:44 | ⇒ sheare strength :-

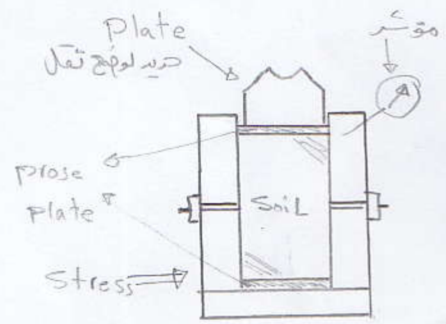


taw

. shear strength $(\tau) = C + \sigma \tan \phi$

shear strength pramter (C, ϕ) (Cohision, angle of frection

① Direct shear test (shear box)



⇒ advantages of (D.S.t) :-

① it's sample test.

② Fast.

③ no. Experiance required.

④ Cost less

⇒ dis advantages of (D.S.t) :

① error in shear area betwean sampl

② Fixed failere plane

③ Can't measure pore water pressure (total strength pramter)

---

* strength pramter :

① total strength pramter :- σ', U

$\sigma = \sigma' + U$

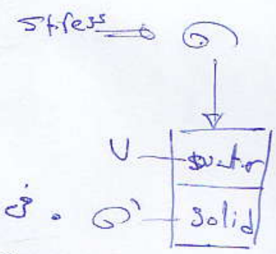
efficion stress

water or stress

eff. frection

. في هذة الحالة تتكون العينة والمياة

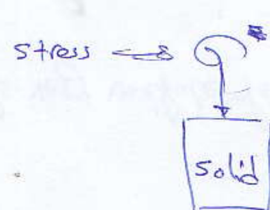
. لتا وقت الحل



→ :- C_u, ϕ_u (undrained cohison (C_u), undranid internal angle frection (ϕ_u))

② Effective stress pramter :-

σ', $U = 0$



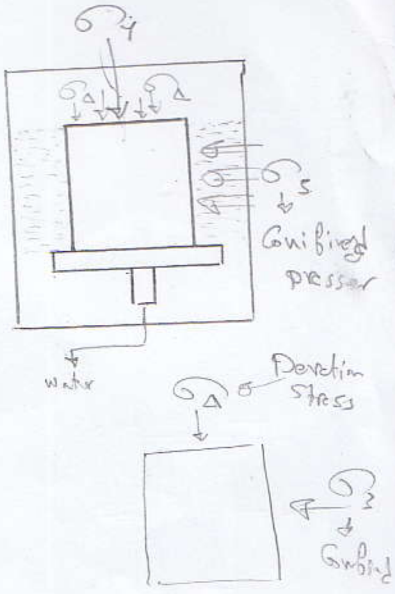
$C', \phi' \Rightarrow$ (effictive Cohision, internal frection)

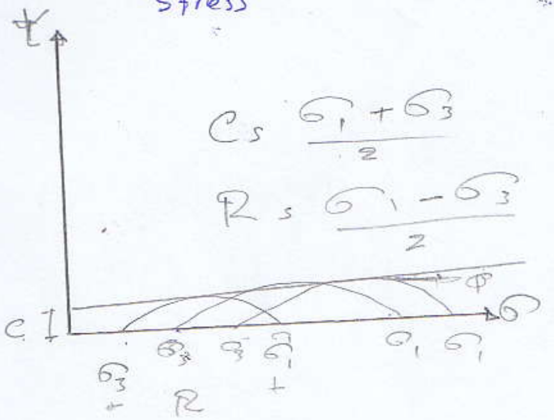
② triaxial test (ضغط ثلاثي المحاور)

$\sigma_1 = \Delta\sigma + \sigma_3$

$\Delta\sigma \rightarrow$ Normal stress

$\sigma_3 \rightarrow$ Conified presser الضغط الكاتم





*) triaxial arrangment :

① Un Consolidation - undrained (UU)

$\sigma_3 \Rightarrow$ Valve Closed , $\sigma_1 \Rightarrow$ Valve Closed

② Consolidation - undrained

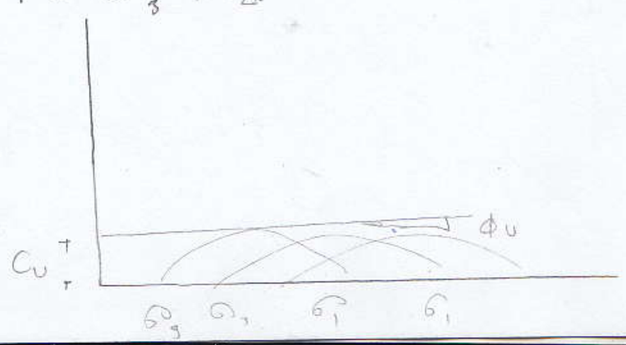
$\sigma_3 \Rightarrow$ valve opened , $\sigma_1 \Rightarrow$ valve closed

③ Consolidate - drained

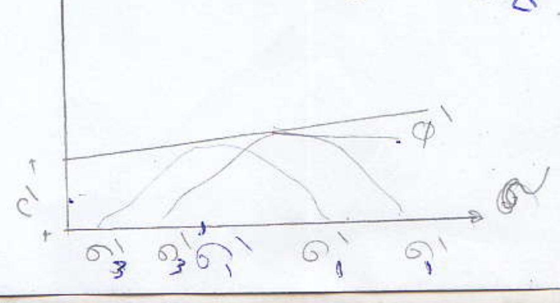
$\sigma_3 \Rightarrow$ " opened - $\sigma_1 \Rightarrow$ " opened

test no.	Confied pran. σ_3	Devetion stress σ_Δ	u P.W.P	σ_1'	σ_3'	σ_1
1	1	1.2	0.6	σ_1 - pwp	σ_3 - pwp	
2	2	2.3	1.3			
3	3	3.3	2.1			
4						

$\sigma_1 = \sigma_3 + \sigma_\Delta$



$\sigma_1' = \sigma_3' + \sigma_\Delta'$

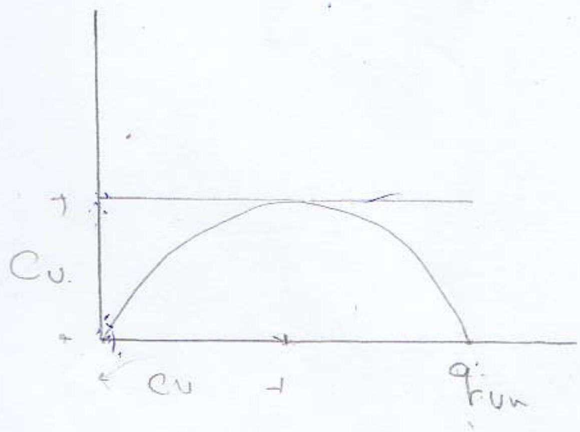


3) unconfined compressive strength test :

* σ_1 at failure = q_{un} , $\sigma_3 = 0$

وهذه الحالة تستخدم للطين فقط لذلك لا تكون هناك زاوية احتكاك بين الحبيبات $\boxed{\phi = 0}$

* $C_u = \dfrac{q_{un}}{2}$, $\phi = 0.0$



$$q_u = \frac{P}{A} \quad \frac{\text{load}}{\text{Area}}$$

⇒ advantages : 1) Sample test
2) fast
3) accuret.
4) Cost less.

⇒ dis adv. : 1) Used for Cohisev soil only
2) Can't determine effective strength pramter.

σ_2 τ_N q

sec/ 12

①

Compresability ← الهبوط

ملحوظة

Immediate settelment هبوط لحظي

عند الهبوط السريع

(رمال - زلط ← 90%)

⇒ due to:

- Expantion of air from soil
- 〃 〃 water from Cohsion soil

Primary Consildation

- الهبوط مع مرور الزمن
- ويكون حسب قوة التربة
- وعلى تسرب المياة.
- Expansion of water for "Cohesive soil"

ملحوظة

Secondry Consolidation

عند حدوث تشكل الحبيبات من الضغط الواقع

- Deformation of soil solid particals.

Consolidation

- is the Decrease in volume due to expantion of water from fully saturated Cohsive soil.

⇒ to occur Consolidation:

1. Exernal presser. قوة خارجية
2. Cohsive soil. تربة (طينية)
3. fully saturation. عينة مشبعة تماما

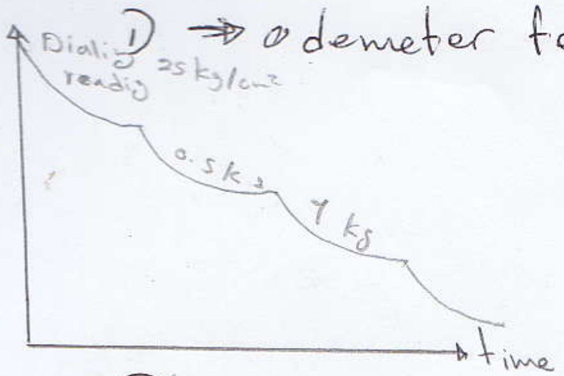
⇒ purpose to study: ① Determine the amount of Consolidation

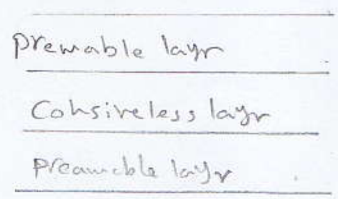
② rate of Consolidation.

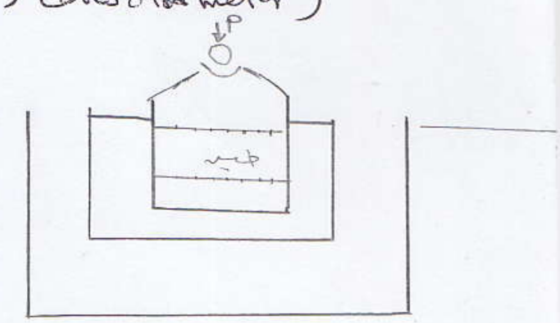
→ Determination of ~~mine~~ main Con. pramter :

→ in lab :

1) → odemeter test (Consolidation , Consolidmeter)



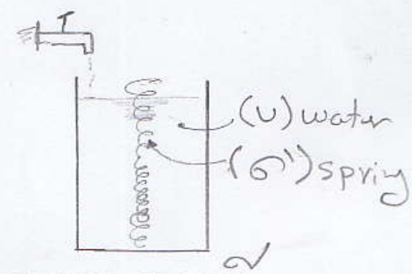


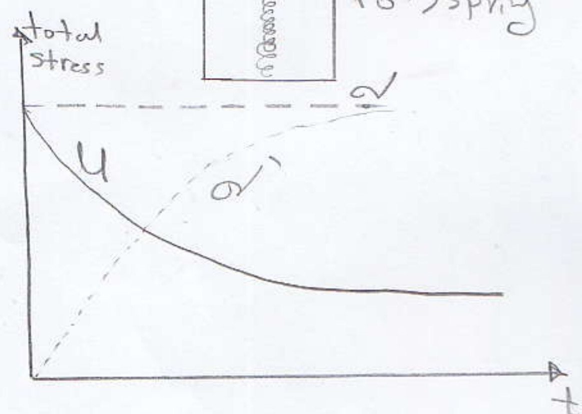


2) → Spring analogy : ✱ مهم

- phase 1 : Valve open $\sigma = AU + (A-1) * \sigma'$
- phase 2 : Valve closed $\sigma = U$
- phase 3 : final stage $\sigma = \sigma'$

  $U = 0.0$ عشان عدم وجود مقاومة للماء.



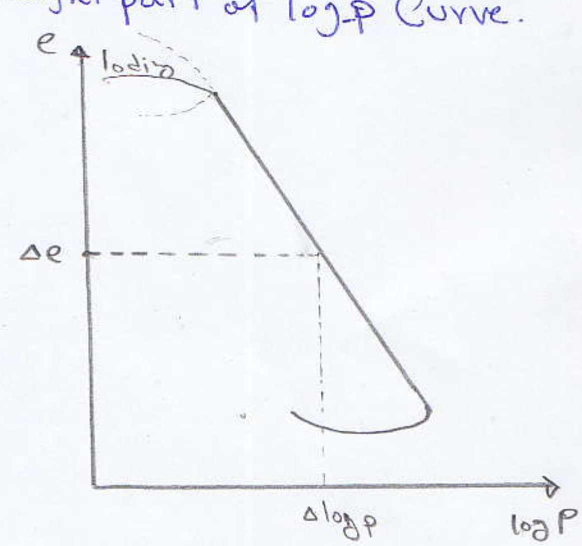


✱ main Consolidation pramter :

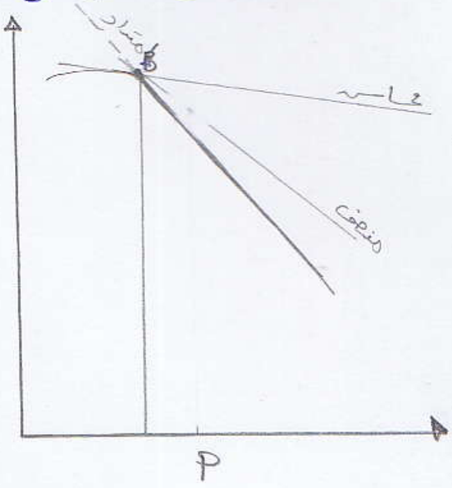
1) e-Plog Curve.

2) Compression Index (C_c) : the slope of straight part of log-p Curve.

$$C_c = \frac{\Delta e}{\Delta \log P}$$



3) pre Consolidation pressers : لتحديد أكبر حمل تم تحمله وهو ضغط التحميل



1) Determine point of max Curvature.

2) Draw a horizontal line at point A

3) 〃 a tangent line at point A

4) Draw Bisection line.

5) Extend straight line of Curve to intersect the Bisection at B , to get P_c

- σv_o = overburden presser.
- P_c = preConsolidation presser
- over Cons. presser. (O.C.R) = $\dfrac{P_c}{\sigma v_o}$

If

- OCR = 1.0 ⇒ soil normally Consolidation
- OCR > 1.0 → O.C soil
- O.C.R < 1.0 → Preconsolidation soil

Sec / 13

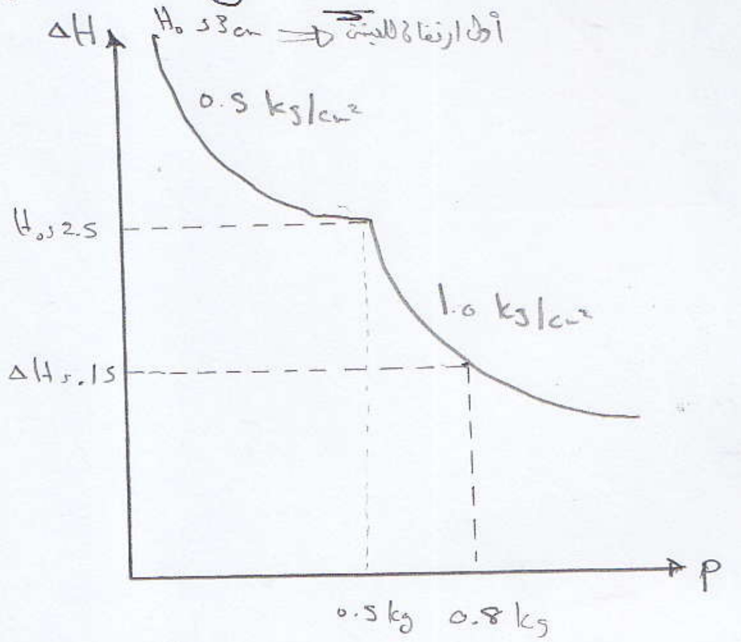
Consolidation

5) Coefficition of Volume Compressibilty (m_v)

$$m_v = \frac{\Delta H}{H_o(\sigma - \sigma_o)}$$

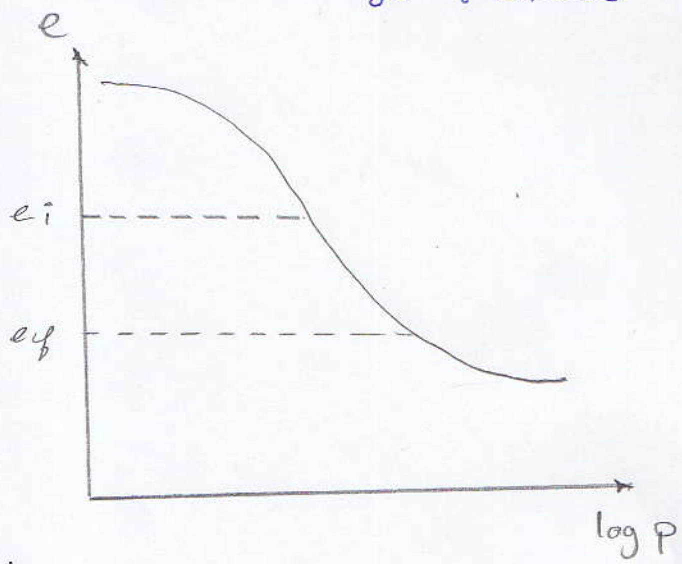
σ_o → overberdun presser

$$= \frac{0.15}{2.5(0.8 - 0.5)}$$



m_v : is the change in volume of soil due to change of strees From σ_o to σ

$$C_c = \frac{\Delta e}{\Delta \log p}$$



$$S_c = \frac{C_c}{1+e_o} H_o \log \frac{\sigma_o + \Delta\sigma}{\sigma_o}$$

→ قيمة الهبوط

For normally Consolidation soil

S_c = Cons. settalment

C_c : Compression index

e_o : intial thickness

H_o : layer thickness

σ_o : over berdun pressur

$\Delta\sigma$: net stress

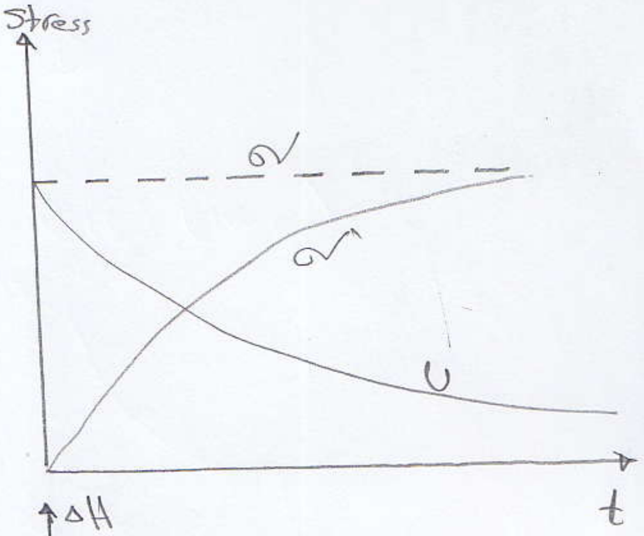
$$\therefore S_c = m_v * H_o(\sigma - \sigma_o)$$

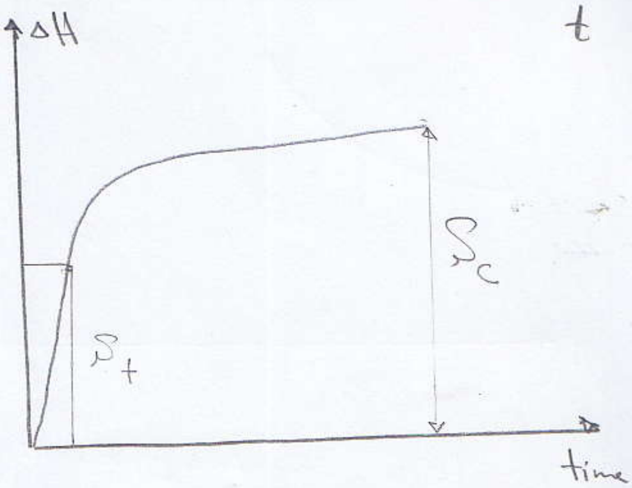
* time rate Consolidation :

$\frac{S_t}{S_c} = U$ ⇒ Sattelmant Coefficiant

⇒ terzaghe's therory :

1) Soil isotropic soil.
2) ״ fully saturated.
3) ״ partial and water are incombrasabile.
غير قابلة للانضغاط.
4) strian are small.
5) perambility of soil remainss Constant
6) thereis aunique relation between stress and deformation of soil dependant of time.





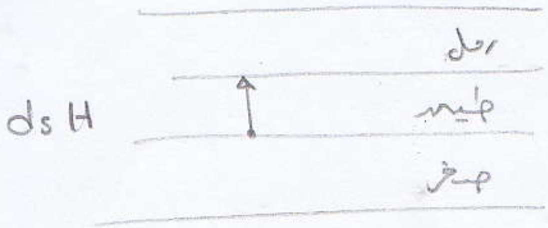
$$t = \frac{T_v * d^2}{C_v}$$

t : time required to rach aspecific settelment — الزمن اللازم حتى الهبوط

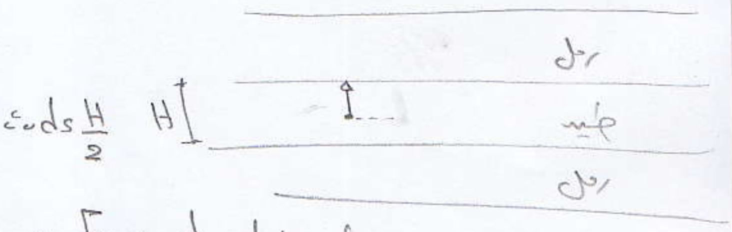
T_v : time fraction (Coeff) from table based on U

d : maximum drainge path For water.

C_v : Consolidation Coeff.



* For single drainge



* For double dranige soil.

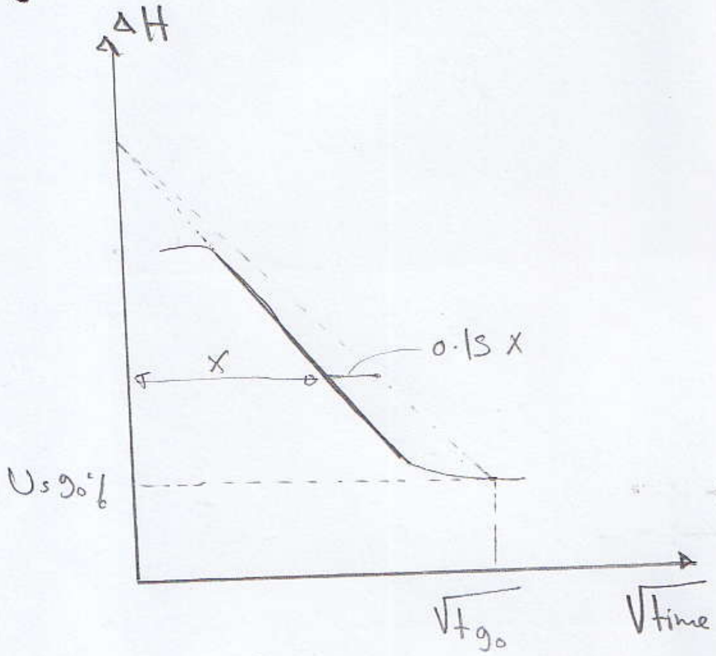
* Determine of C_v:

1) squre root of time Method (talyr's method)

$$t_{90} = \frac{t_v * d^2}{C_v}$$

t_v of $U = 90\%$

$\quad \rightarrow = 0.848$

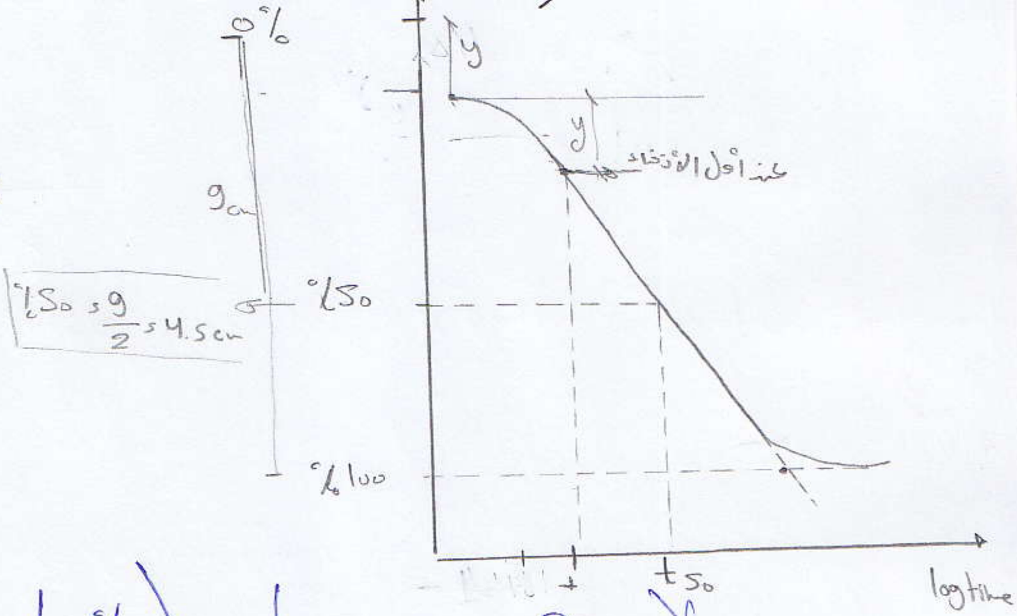


2) log time method (Cassa grand's method)

t_v at $U = 50\%$

$\quad \rightarrow = 0.197$

$$C_v = \frac{0.197 * d^2}{t_{50}}$$



$C_c = 0.009(L.L - 10\%)$, $k = m_v * C_v * \gamma_w$

See : قبل الإختبار

(R.s) Retaining structure ⟸ المنشآت الساندة

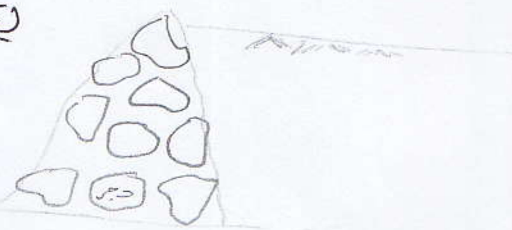
Internally Stabilized (المنشآت الساندة) type
- reinforced soil التسليح
- soil nails عزز أسياخ
- Micro piles خوازيق

. Soil Reinforment
أعمال الردم
خوص التربة

Externally stabil حوائط ساندة (Retaining wall)
- Conventional R.S
- Modern R.S

1 ⟹ Conventional (R.s) :-

- Resist latural load by : يقاوم الأحمال عن طريق
  1) own weight. وزن التربة
  2) Bask width. عرض القاعدة

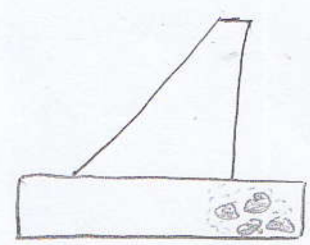


a) Gravity R.w (Ratining wall)

⟹ from : stone, Masonry, bracks
حجر, حجر مشكل, طوب

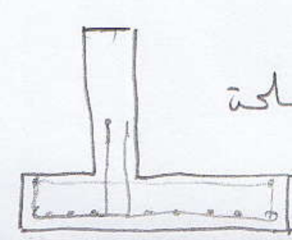
b) Sami - Gravity : (R.w)

⟹ from : plain Concret



خرسانة عادية

c) Cantliver (R.w) :

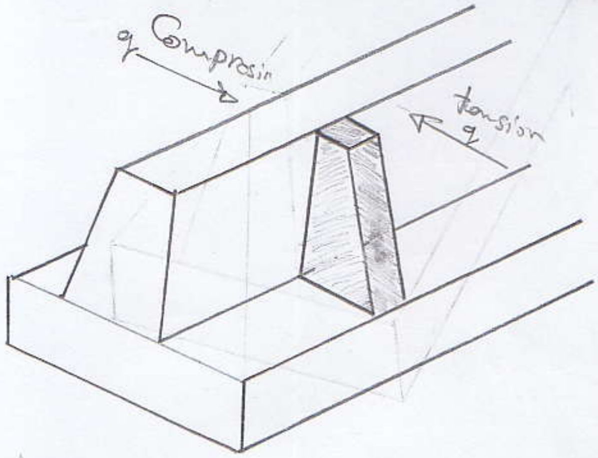


خرسانة مسلحة

⟹ from Renforced Concret

d) Buttrassed (R.w)

Comprsion الو العصب شايل



e) Countefort (R.w)

tension لو العصب شايل

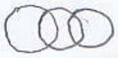
⇒ Modern (R.S):

- Resistance load lateral by:

1) pentration depth.

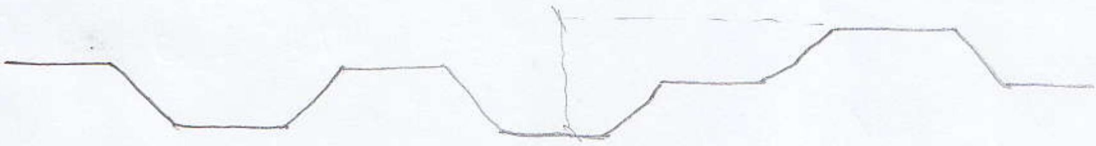
2) wall stiffnese.

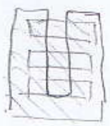
⇒ type:

1) Secent piles wall  خوازيق متقاطعة

2) tangent piles wall. 

3) sheet piles wall.



4) Diaphragm wall 

⇒ type of loads on (R.w)

1) Down weight.

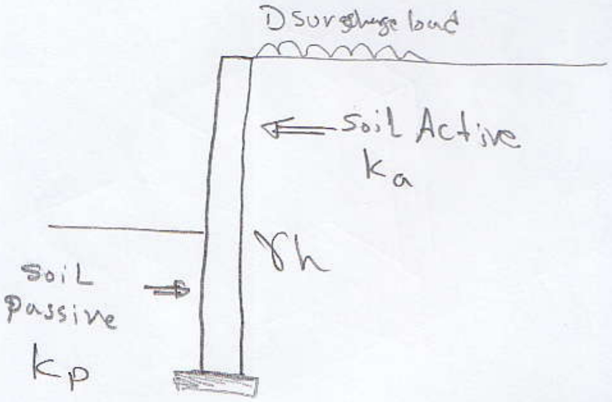
2) surcharge load.

3) Ground water.

4) Cohsion soil.

HL VL

- $\sigma_3 \propto \sigma_1$



$\sigma_3 = k * \sigma_1$

Lalatral earth pressure Coeficient.

∴ k_a : Active lateral. تقادم الضغط

k_p : passive lateral. تقادم التربة العكسية

k_o : atrest latral earth pressar. Coef.

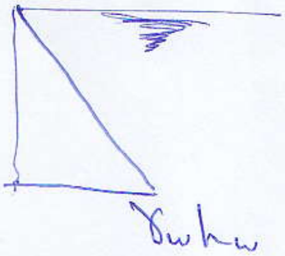
⇒ Digrame of load in (R.W)

1) own weight of soil :

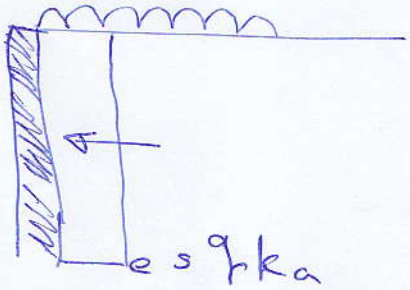
$\sigma_3 = k\sigma_1$

2) Ground water (G.W.T)

$\sigma_3 = k\sigma_1$

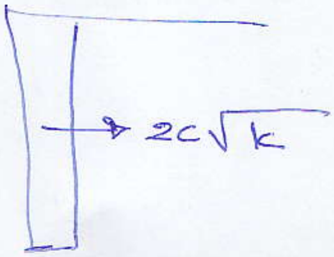


3) Surcharge loads :



4) Cohsion :

$\sigma_3 = 2C\sqrt{k}$

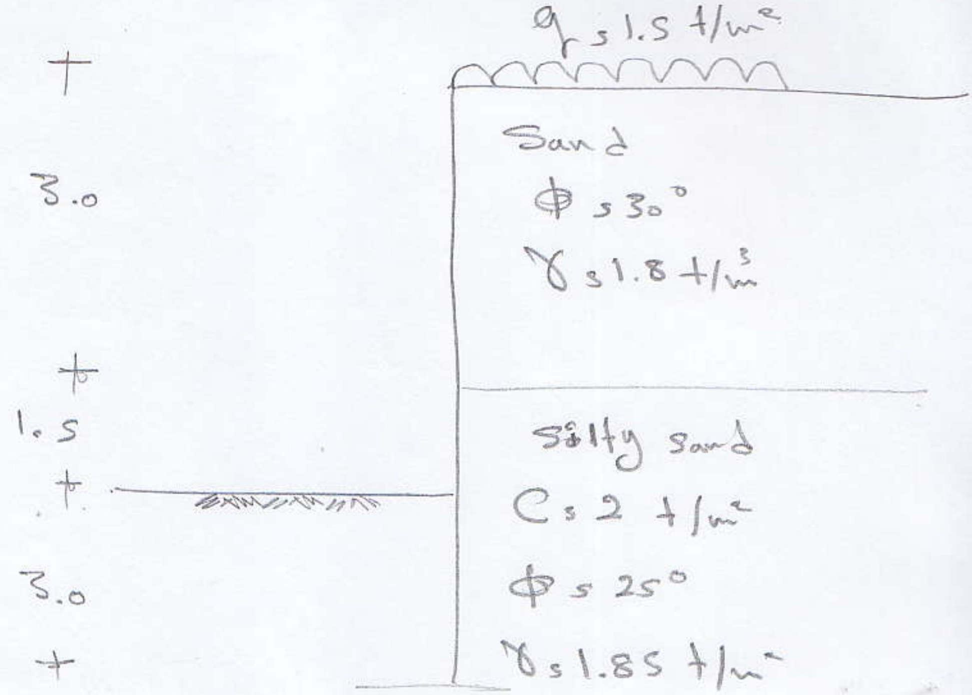


Example

$K_o = 1 - \sin\phi$

$K_a = \dfrac{1-\sin\phi}{1+\sin\phi}$

$K_p = \dfrac{1+\sin\phi}{1-\sin\phi}$



Solution :

1) Soil properties : a) layer 1)

التربة الرخوة Active فقط

$\gamma = 1.8\ t/m^3$

$\phi = 30°$

$c = 0.0$ $\quad K_a = \dfrac{1-\sin 30°}{1+\sin 30°} = 0.33$

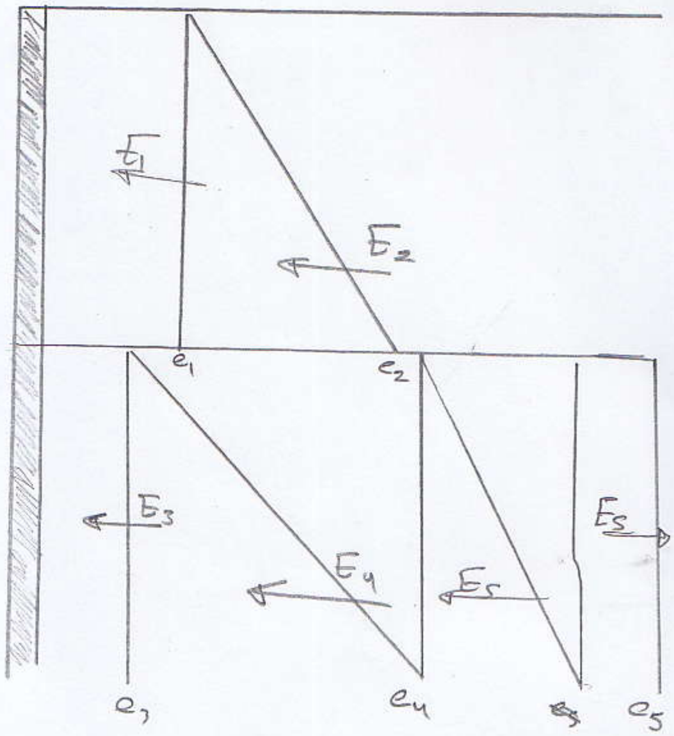
b) layer 2)

$\gamma = 1.85\ t/m^2$

$\phi = 25°$

$c = 2\ t/m^2$ $\quad K_a = \dfrac{1-\sin 25°}{1+\sin 25°} \simeq 0.4$

$\therefore K_p = \dfrac{1}{K_a} = 2.5$



Item	L. E. presser	L. E. Forceing	
surcharge 1.	$e_1 = q\,k_a = 1.5 * 1/3 = 0.5\ t/m^2$	[illegible] $E_1 = e_1 * h$	Sand
own weight 2.	$e_2 = \gamma_{b_3} h\,k_a = 1.8$	$E_2 = 0.5 * 1.8 * 3$	
surcharge 3.	وزن التربة + حمل خارجي $e_3 = [\underbrace{1.5 + 1.8 * 3}_{q}] * k_a$	$E_3 = e_3 * 4.5$	
weight 4.	$e_4 = \gamma_{sub} h\,k_a$	$E_4 = 1/2 * e_4 * 4.5$	Silty-sand
5)	$e_5 = \gamma_w \cdot h_w = 4.5$	$E_5 = 1/2\ e_5 * 4.5$	
	$e_6 = 2c\sqrt{k}$	$E_6 = e_6 * 4.5$	

Foundation :

stress = $\sigma_v = \frac{P}{A}$

∴ Area desigin = $A = \frac{P}{B.C}$ → Bearing Capacity.

→ Bearing Capacity : is the maximum stress that Can be withstand by soil within allowble sattlment.

→ (B.C) eqution :

$$q_{ult_{net}} = C N_c \lambda_c + \gamma_1 D_f N_q \lambda_q + \gamma_2 B N_\gamma \lambda_\gamma - \gamma_1 D_f$$

→ where : • C : Soil Cohsion تماسك التربة

→ • N_c, N_q, N_γ : B.C factor, get from table with ϕ

at $\phi = 0.0$, $N_c = 5.0$, $N_q = 1.0$, $N_\gamma = 0.0$

→ • $\lambda_c, \lambda_q, \lambda_\gamma$: shape factor

$\lambda_c = \lambda_q = 1 + 0.3 \frac{B}{L}$

$\lambda_\gamma = 1 - 0.3 \frac{B}{L}$

→ • $\gamma_1 D_f$: surcharge load of foundation حمل القاعدة F.L (foundation level)

→ • γ_2 : unit weight of soil beneath footing

→ • B : ~~B~~ footing width

* B.C (safe) or (allowable) :-

$$q_{all_{net}} = \frac{q_{ult_{net}}}{F.O.S \rightarrow 3.0}$$

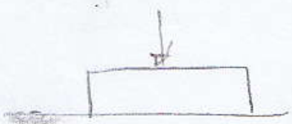
⇒ Factor of (B.C) :-

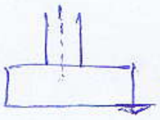
1) type of soil
2) Soil Cohsion
3) angle of internal friction
4) shape footing
5) Depth of foundation.
6) footing width.
7) Ground water.
8) load direction.

Foundation

$\xleftarrow{Yas}$ $D_f \leq 2.5B$ $\xrightarrow{No}$

Shallow



1) Isolated footing


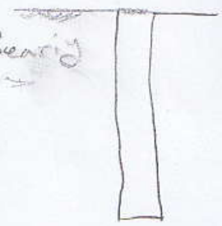
2) strip footing


3) Compine footing

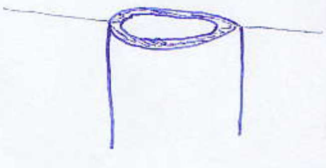

4) strip Beam footing


5) Raft. لبشة

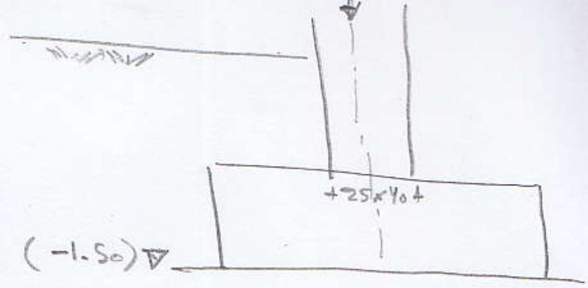
Deep



1) piles خوازيق


2) Caissons خوازيق مفرغة


⇒ Desigin of foundation :



B.C = 20 t/m³

+ 2 * 3 m +
B * L

1) footing Dimension :

$$A = \frac{P_w}{B.C} = \frac{120}{20} = 6.0\ m^2$$

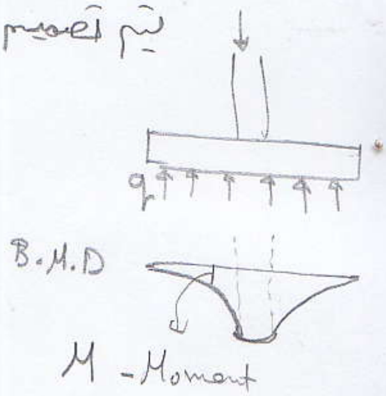
$$\therefore B * L = 2 * 3 = 6\ m^2$$

notes :

$P_{ult} = 1.5 * P_w$

2) straining action : يتم تصميم القاعدة على اساس رد فعل التربة

$$\therefore q = \frac{P_{ult}}{A} = \frac{1.5 * 120}{6.0} = \boxed{}\ t/m^2$$

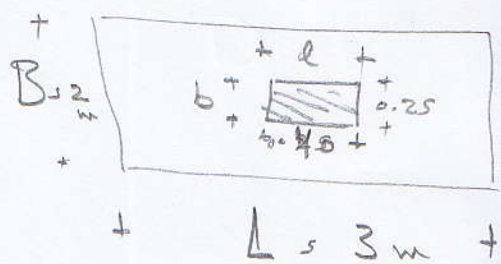


في الاتجاه الكبير

$$\bullet\ M_I = q\,\frac{(L-l)^2}{2} \Big/ 2 = \boxed{}\ t$$

في الاتجاه الصغير

$$\bullet\ M_{II} = q\,\frac{(B-b)^2}{2} \Big/ 2 = \boxed{}\ t$$



3) footing thickness :

$$d = C_1 \sqrt{\frac{M_{ult} * 10^5}{F_{cu} * 100}}$$ where : $C_1 = 5$ at $J = 0.826$

$$d_I = 5 * \sqrt{\frac{M_I * 10^5}{250 * 100}}$$

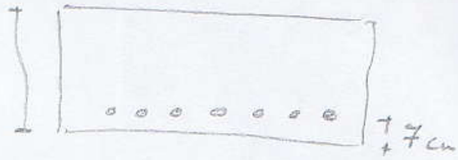
$$d_{II} = 5 * \sqrt{\frac{M_{II} * 10^5}{250 * 100}}$$

نختار الـ d الأكبر

ويكون هو سمك القاعدة

- $t = d + 7\ cm$
  $= 53.33 \simeq 55\ cm$

تقرب لأقرب 5



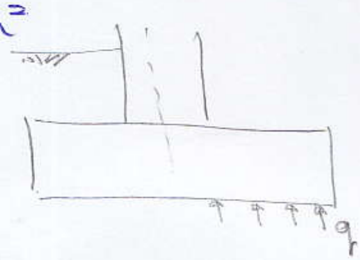
4) Cheack shear :-

** خلي بالك من التحويلات والـ unit

$$Q_{u_I} = q_r * \left[\frac{(L - \ell - d)}{2} \right]$$

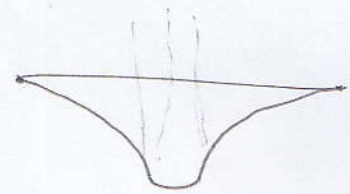
where $d = 55 - 7$
$= 48\ cm$
$= 0.48\ m$

$$Q_{u_{II}} = q_r * \left[\frac{(B - b - d)}{2} \right] = \boxed{--}\ t/m^2$$

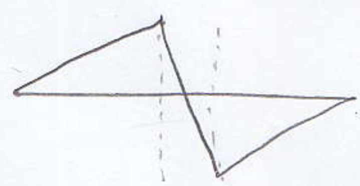


∴ Maximum stress :

B.M.D



S.F.D

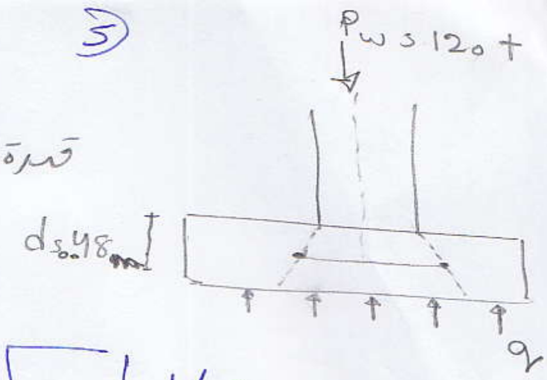


$$q_{u_I} = \frac{Q_u I * 10^3}{d * 100} = \boxed{..}$$

$$q_{u_{II}} = \frac{Q_u II * 10^3}{d * 100} = \boxed{..} \rightarrow \leq 1.3 * 0.75 * 0.5 \sqrt{\frac{F_{cu}}{\gamma_c}}$$

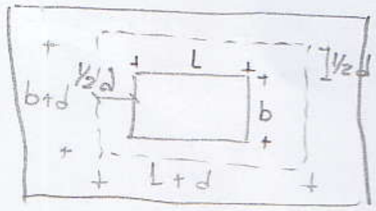
γ_c = 1.5

5) check punctioning : قدرة الاختراق



• $Q_{up} = P_u - q * (l*d) + (b*d) = \boxed{\quad}\ t/m^2$

$$q_{up} = \frac{Q_{up} * 10^3}{2[(L+d)+(b+d)] * d}$$



$$q_{up} \leq \left(0.5 + \frac{b}{L}\right)\sqrt{\frac{F_{cu}}{\gamma_c}}$$

غير ذلك نقوم بزيادة السمك (d)

6) Reinforcment (التسليح)

• $A_I = \frac{M_{UI} * 10^5}{j * f_y * d}$ = $\boxed{\text{total}}$ ∅ $\boxed{\text{سيخ واحد}}$ m'

مساحة الأسياخ ... مساحة الأسياخ

$j \rightarrow 0.826$, $f_y \rightarrow 3600$

• $A_{II} = \frac{M_{uII} * 10^5}{j * f_y * d}$ = $\boxed{\text{total}}$ ∅ $\boxed{\text{سيخ واحد}}$ m'

$A_s \geq 0.15\% (b * t)$

$b \rightarrow 100$; t: السمك هنا النهائي

$\frac{\text{total}}{\text{سيخ واحد}}$ = عدد الأسياخ ∅ اللي فرضته ← $\frac{\pi}{4}(12)^2$
لو أكبر من 10 أكبر ∅ والعكس

عدد الأسياخ لا تزيد عن 10 ولا تقل عن 5

7) Details :